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AGENT SYSTEM APPLICATION FOR GEOINFORMATION MANAGEMENT AT MUNICIPAL OFFICE

ZASTOSOWANIE SYSTEMÓW AGENTOWYCH DO ZARZĄDZANIA GEOINFORMACJĄ NA POZIOMIE URZĘDU GMINY

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Introduction

Nowadays, the management of geoinformation in governmental and public administration information systems requires an ontological approach to ensure compatibility and interoperability of these systems. e-Government is seen as a citizen-centric, empowering mechanism which offers enhanced choice, access, inclusion and quality of information. An added public value in e-Government is gained through activities that form, develop, or prepare an information product (i.e. administrative decision) in all its features and its environment (service channels, marketing etc.) in a way that is valuable for the petitioner. The ASSISO system is a prototype hybrid interface agent implementation, providing citizens with knowledge-based access to municipal services (Stanek et al., 2008). The paper describes the ontology construction issues for agent systems as well as their connection with Geographical Information Systems (GIS).

Ontology and geo-ontology

Originating in the early nineties in knowledge acquisition research, ontologies came about through the conceptual shift from the knowledge transfer view of knowledge acquisition to the knowledge modeling view. Now applied for developing knowledge-based systems, ontologies have been classified into domain ontologies, method ontologies, task ontologies and top-level ontologies that cover the different aspects of knowledge-based modeling systems. There has been some agreement in the computer science community on the definition of ontology based on (Gruber, 1993): *An ontology is a formal explicit specification of a shared conceptualization for a domain of interest*. According to this definition, an ontology has to be specified in a language that comes with a formal semantics. The formal approach is necessary for ontologies to provide the machine representation of concepts and relations that represent and define the knowledge modeled. Ontologies depend upon the social process that leads to agreement among a group of people with respect to the concepts and relations involved. Because ontologies aim at consensual domain knowledge, their development is often a cooperative process involving different people – possibly at different locations. Ontologies, as consensual models of meaning, can only arise as the result of a process where agents agree on a certain model of the world and its interpretation and are a pre-requisite for the creation of models in which intelligent agents interact.

Most of the existing ontologies are built using ontology building tools whose editors allow the easy creation of taxonomies, either from web-based forms or with graphical tools. Examples of such tools are OntoEdit, Protege2000, WebODE and WebOnto. All of these support the structuring of domain concepts in taxonomies and permit the creation of ad-hoc relationships between them. Many authors recommend UML as a representation language for ontologies. The advantage of using an UML development environment is that standard software development tools can be used to build ontologies. A disadvantage is that such tools may provide less support than customized special-purpose ontology editors. The ontology evaluation field is just emerging. There many published libraries of ontologies and some of the most known are:

- DAML ontology library http://www.daml.org/ontologies/
- Protégé ontology library http://protegewiki.stanford.edu/index.php/Main_Page
- Ontolingua ontology library http://ksl.stanford.edu/knowledge-sharing/ontologies/
- WebOnto ontology library http://kmi.open.ac.uk/projects/webonto/
- SHOE ontology library http://www.cs.umd.edu/projects/plus/SHOE/onts/index.html
- WebODE ontology library http://webode.dia.fi.upm.es/
- $(KA)^2$ ontology library http://digbib.ub**ka**.uni-**ka**rlsruhe.de/volltexte/documents/1786

Geo-ontology is a kind of domain ontology and offers vocabularies and relationships defining concepts in the geographic spatial information domain. As far as the geographical structures and classification system are concerned, the relationships among the geographical concepts are hierarchical, being the relationship between the parent concepts and the child concepts or between hypernyms and hyponyms. A geographical concept can be navigated to its parent concept or child concept, and implements the automatic generalization of geographic spatial data by merging the features in the geographical feature classes corresponding to all child concepts of the some geographical concept in geo-ontology (Huang et al., 2007).

Even though the term ontology has been widely used by the GIScience community for up a decade now, building a geographic ontology has not proven an easy task. The absence of consensus among GIScientists reflects the difficulty in describing all the special characteristics of the given domain, and a lack of concensus regarding the source and formalization of the domain semantics. The OWL Web Ontology Language is designed for use by applications that need to process the content of information, distributed across the World Wide Web, instead of just presenting information to humans. OWL facilitates machine interoperability of Web content by providing additional vocabulary along with a formal semantics and is a language for defining and instantiating Web ontologies. Examples of the geographic ontologies are available at http://ontogeo.ntua.gr/ as well as at other sites i.e.

http://www.ncgia.buffalo.edu/i21/ontology.html,
http://www.geonames.org/ontology/,
http://www.loa-cnr.it/ontologies/SpatialRelations.owl.

A number of features of geographic information and its applications suggest that ontology can be particularly useful in this area. Specifically, GIS applications exemplify the following factors: a diverse vocabulary of highly interdependent concepts; terminology is deeply affected by conceptual ambiguity and vagueness; lots of complex data is available; and applications require very flexible interpretation of data. An ontology may provide a solution to certain problems in manipulating spatial information that arise due to lack of precise specification of the meanings of geographic terminology (Harding, 2002).

Application of ontology in e-Government

e-Government applications are oriented towards the automation of administrative processes and communication between citizens and governmental agencies to ensure relevant information for the Internet user. Public administration information systems are oriented towards propagation of information on the availability of services, their mode of use and the electronic delivery of forms and documents to municipal offices.

With the present development of the Semantic Web, these solutions can provide access to information concerning services, their realization way, office activities, officers and geospatial information. With the application of ontology-directed artificial intelligence methodologies, this information can be further processed to provide support for decision making.

Peristeras et al. (2008) describe a huge diversity of ideas for ontology construction to support public administration. Following this, we have proposed an ontology within the ASISSO interface agent system to manage the public administration domain knowledge for citizen access. An ontology to define the domain knowledge for citizen access to public administration services is proposed by the ASISSO development project. This ontology defines the formalisms concerning agent system knowledge structure and is expressed in OWL. The main concepts are presented in Figure 1.

Figure 2 presents a fragment of the knowledge in RDF format.

The structure of the ontology, because of its universality, can easily be extended to include geospatial information. Figure 3 illustrates the extension of co-ordinate concept by WGS84 ontology (http://www.w3.org/2003/01/geo/).

Geographical Information Systems Development Problems

The development of our geographical information system is accompanied by the construction and practical implementation of different multitasking tools supporting space management as well as the construction of multimedia elements. The interface agent module is the next extension of the GIS. Because of the diversity of commercial GIS products and their conservative approaches to hardware and software technology, achieving interoperability with these systems will be difficult, although some modern GIS products now support graphical data as well as relational and object- oriented databases. There is pressure on defining the identification rules among objects in semantic databases and image databases and it is necessary to implement procedures for modifying and updating data forms for their further usage. Gathering geographical data is an expensive and time-consuming activity, so to facilitate the re-use of these data it is necessary to adopt standards for the transfer of data among users and systems. Contemporary IT solutions permit for transfer, conversion and re-usage of the same maps which are assumed to be defined data structures. Geographical data, semantics, metadata, geometry, data for transformation, topographic and logical consistence and information on timeliness of data are transferred in geoinformation systems. For the integration of geoinformation systems with other information systems, there is need for standardization and compliance with certain requirements. Standardization of GIS should rely on:

- Establishing a unified, consistent terminology applied for standards and defined objects (units) and relations among their features,
- Creation of the reference schema for defining the location of points and semantics (defining the types of objects, their relations and attributes),
- Selection of the Data Definition Language, for specifying the structure of database,
- Selection of the Data Manipulation Language for updating and querying the database,
- Defining the univocal forms of data transfer and mechanisms for data exchange among systems (catalogue and dictionary metadata),
- Development of conceptual models, to define the semantics for describing and drawing geographical entities (geometry with location, shape and data structure),
- Development of the application schema, particularly in the case of complex objects, when the application integrates a number of data sets, for which schema are available,
- Specification of processing models covering current forms of data transfer and the processes for modification and querying.

There are a number of international standards concerning transfer and exchange of geographical data:

- ISO/TC 211 is responsible for some 41 published standards, principally ISO19101 and its associates,
- International Hydrographic Organization SP57 I DX 90 standards,
- DGWIG (Digital Geographic Information Working Group) Digital Geographic Exchange Standard (DIGEST) for transfer of data among national systems in NATO structures,
- European Territorial Data Base (ETDB) standard elaborated by Comite European de Responsables de la Cartographie Officielle (CERCO) for connecting existing and future national data sets,
- CEN/TC 287 standard,
- Geographic Data File (GDF) 2.0 standard elaborate by Drive ECRM/CEN/TC 278 for transport and logistics.

Establishing the common format for data is necessary for complete integration of a spatial information system with other systems; for reviewing and using the digital map; for data update and maintenance; for data visualization; for data processing and publication in the Internet and for reliable and fast exchange of data and univocal interpretation by Internet browsers. A more advanced approach is to transfer the data required to create the map or report to the client computer and to render this through the browser, using, for example, a Java applet. However the information is delivered, the end user requires tools to enable interaction with the information, for example map reviewing, searching out buildings, streets, objects, performing spatial analysis, increasing/decreasing selected map fragments and choice of map edition. ASISSO, the interface agent system, includes a module for the presentation of geoinformation. This module provides connection to the system server for map facilities and delivery of maps to the computer screen. For example, the end-user can be connected to the map server for the display, searching out, scaling and manipulation of the implemented maps.

In conclusion, modern information technologies offer radical changes in engineering and exploitations of Geographical Information Systems. The implementation must be based on widely applied standardization and ontology engineering to enable interoperability and further development and the agent technology offers solutions to facilitate map usage.

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Abstract

Electronic public administration systems recently developed in Poland, i.e. SEKAP and e-PUP, support document flow and ensure access to integrated information on municipal services, which hitherto was presented in Public Information Bulletins. However, the information presented to the citizen in the administrative process is not easily understandable, so we propose an agent system to support the citizen's decision process. Based on the mechanisms for interpreting knowledge included in ontologies, the agent system will support users' behaviours in communication with municipalities as well as delivery of documents and information discovery. The first part of the paper presents a discussion on ontologies and geo-ontologies that could be applied in agent systems. The second part presents our ontology application in ASSISO, interface agent system, which is implemented to support online communication among citizens and virtual municipal office. The third part explains links among ASISSO interface agent system and GIS.

Streszczenie

Aktualnie tworzone systemy SEKAP oraz e-PUAP zapewniają dostęp do zintegrowanej informacji na temat realizacji spraw, usług, które dotychczas prezentowane były poprzez portale BIP oraz wspomagają proces kontaktu z urzędem poprzez możliwość przesyłania dokumentów. Jednak w procesie *realizacji danej usługi interpretacje informacji, jakie prezentowane są użytkownikowi, może być trudna w oparciu o wiedzę, jaką dany mieszkaniec posiada. Aby wspomóc procesy decyzyjne użytkowników możliwe jest zastosowanie systemów agentowych, które w oparciu o mechanizmy interpretacji wiedzy zawartej w ontologiach wspomagać będą działania użytkownika w kontakcie z urzędem, wypełnianiem dokumentów lub wyszukiwaniem niezbędnej informacji. Pierwsza część opracowania obejmuje analizę ontologii i geoontologii, w drugiej przedstawiono zastosowanie ontologii w systemie agentowym ASISSO. W części ostatniej wyeksponowano znaczenie standaryzacji we współczesnych systemach GIS oraz zwrócono uwagę na możliwości ich łączenia z systemami agentowymi.*

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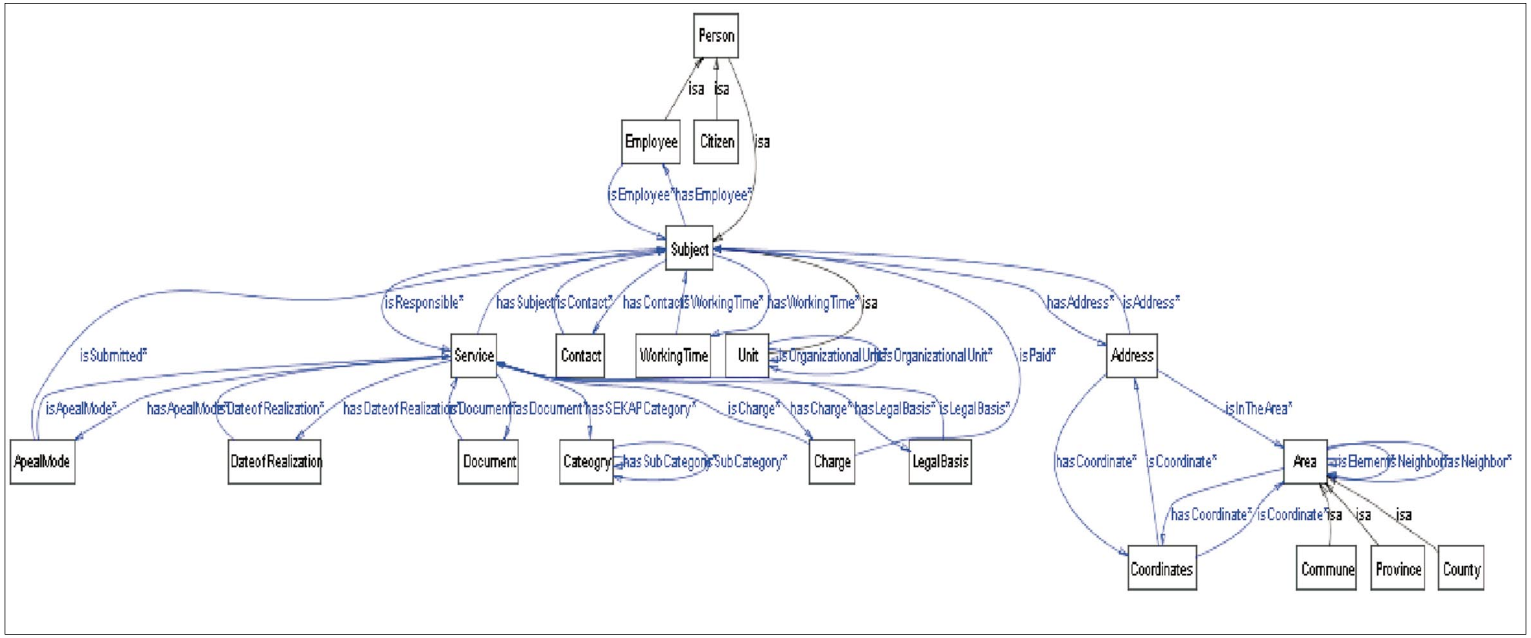

Figure 1. Visualization of ontology presenting ASISSO, hybrid interface agent system knowledge
Sources: Own

```
….
 <hasAddress>
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       >Michałkowicka</street>
       <building rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
       >105</building>
       <isAddress rdf:resource="#Jednostka_35"/>
     </Address>
   </hasAddress>
   <isOrganizationalUnit rdf:resource="#Jednostka_1"/>
   <hasOrganizationalUnit>
     <Unit rdf:ID="Jednostka_45">
       <hasAddress>
         <Address rdf:ID="Adres_50">
           <isAddress rdf:resource="#Jednostka_45"/>
           <room rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
           >47</room>
           <room rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
           >48</room>
           <room rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
           >49</room>
         </Address>
       </hasAddress>
       <isOrganizationalUnit rdf:resource="#Jednostka_35"/>
       <name rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
       >Referat Katastru Nieruchomości</name>
     </Unit>
   </hasOrganizationalUnit>
….
```

Figure 2. Ontology presenting ASISSO, hybrid interface agent system knowledge in RDF form
Sources: Own

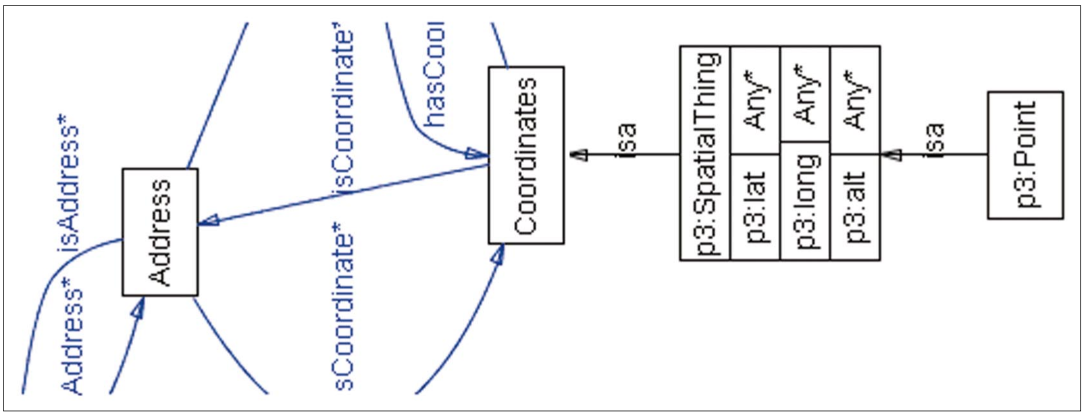

Figure 3. The extension of the ontology using the SpatialThing WGS84 ontology concept
Sources : Own